

## **UNIVERSITI PUTRA MALAYSIA**

EFFICIENCY AND PROFITABILITY OF PEARL MILLET PRODUCTION IN THE NORTH-WEST REGION OF NIGERIA

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### EFFICIENCY AND PROFITABILITY OF PEARL MILLET PRODUCTION IN THE NORTH-WEST REGION OF NIGERIA



Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Doctor of Philosophy

May 2018

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

### EFFICIENCY AND PROFITABILITY OF PEARL MILLET PRODUCTION IN THE NORTH-WEST REGION OF NIGERIA

By

### **UMAR MUKHTAR**

May 2018

Chairman : Professor Zainal Abidin Mohamed, PhD Faculty : Agriculture

This study was conducted to investigate the efficiency and profitability of pearl millet production in northwest region of Nigeria. Primary data were collected from 430 pearl millet farmers through the use of structured questionnaires. Systematic random sampling technique was used for this study. Analytical techniques used for analysis were descriptive statistics, net farm income, OLS and stochastic frontier production model. The descriptive statistics results shows that the respondents had mean age of 39 years with 10.7 years of pearl millet production experience. Greater portion of the respondents (92.60 percent) were males and most of them (67.00 percent) were married. Majority (28.8 percent) of the farmers cultivated between 1.5 to 2.4 hectares of land during 2013/2014 seasons, and about (50 percent) of them acquired their farmland through inheritance. The average household size was 7 persons, while about (43.72 percent) of the farmers had no extension contact during the 2013/2014 cropping season. Although, majority of the farmers (79.30 percent) had formal education, but about (53 percent) of them did not belong to any farmers' cooperative societies. Majority of the farmers (68.8 percent) had no access to credit facilities and higher proportion of them (44.78 percent) sourced their finance through internal financing. Most of the farmers (35 percent) earned between \$159 and \$945 annually as income from pearl millet farming. The results from farm budgeting techniques show that seasonal profitability analysis on per hectare basis with regard to pearl millet production in the study area revealed that a total revenue of \$463.24; total cost of production of \$262.35; gross margin and net farm income of \$233.89 and \$200.89 respectively were realized. Also, PI, RRI and CTO of 0.43, 0.77 and 1.77 respectively were generated. The farm inputs costs that affect profitability of pearl millet production were found to include cost of renting land, cost of fertilizer, cost of labour, cost of seed, cost agrochemicals and output price were the farm inputs costs found to be associated with profitability. The results obtained from the stochastic frontier analysis shows substantial technical, allocative and economic



inefficiencies among smallholder pearl millet farmers. The results reveals that all the six production variables used in the model; farm size, fertilizer, manure, labour, seed, and agrochemical had a positive technical relationship with pearl millet output and were statistically significant. The elasticity of production with value of 1.83 showed that the pearl millet farmers were operating at an increasing return to scale. The result also reveals an average TE of 82 percent. The best practicing and the least technically efficient pearl millet farmers had technical efficiencies of 96 and 64 percent, respectively, while AE estimates ranges from 30 to 91 percent with a mean of 68 percent. The mean EE is 59 percent, with a minimum being 16 percent and a maximum of 90 percent. The results therefore indicate that inefficiency in pearl millet production in north-western Nigeria is dominated by allocative and economic inefficiency. In addition, in the OLS models, farmers' socio-economic factors such as farm size of farmers, type of seed, household size, education, access to credit and extension contact were found to determine technical efficiency. On the other hand, age of farmer, farm size, farming experience; cooperative membership, extension contact and distance to market have positive effects on allocative efficiency of pearl millet farmers. In a similar case, farm size, education, experience, type of seed, cooperative membership, credit and extension contact are the major determinants of economic efficiency. Results of the study revealed a need for strong policies towards ensuring an efficient means of accessing farmland, fertilizer, labour and improved pearl millet varieties accesses. Also, the creation of co-operative societies or joining existing ones should be encouraged. Policies should also be formed to ensure easy and timely access to credit to pearl millet farmers as well as strengthen the extension programs for effective extension services delivery in the study area.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

### KECEKAPAN DAN KEBERUNTUNGAN PENGELUARAN SEKOI MUTIARA DI WILAYAH BARAT LAUT NIGERIA

Oleh

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Mei 2018

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Kajian ini dijalankan untuk menyelidiki kecekapan dan keuntungan pengeluaran sekoi mutiara di wilayah barat laut Nigeria. Data primer dikumpulkan dari sejumlah 430 petani sekoi mutiara melalui penggunaan soal selidik berstruktur. Teknik pensampelan rawak sistematik digunakan untuk kajian ini. Teknik analisis yang digunakan untuk analisis adalah statistik deskriptif, pendapatan ladang bersih, OLS dan model pengeluaran perbatasan stokastik. Keputusan statistik deskriptif menunjukkan bahawa responden mempunyai umur purata 39 tahun dengan pengalaman pengeluaran sekoi mutiara selama 10.7 tahun. Sebahagian besar responden (92.60 peratus) adalah lelaki dan kebanyakannya (67.00 peratus) telah berkahwin. Majoriti (28.8 peratus) daripada petani mengusahakan antara 1.5 hingga 2.4 hektar tanah pada musim 2013/2014, dan kira-kira (50 peratus) daripada mereka memperoleh tanah ladang mereka melalui warisan. Saiz isi rumah purata adalah 7 orang, manakala kira-kira (43.72 peratus) daripada petani tidak mempunyai hubungan lanjutan semasa musim tanaman 2013/2014. Walaupun majoriti petani (79.30 peratus) mempunyai pendidikan formal, tetapi kira-kira 53 peratus daripada mereka tidak menyertai mana-mana pertubuhan koperasi petani. Majoriti petani (68.8 peratus) tidak mempunyai akses kepada kemudahan kredit dan sebahagian besar daripada mereka (44.78 peratus) memperoleh pembiayaan mereka melalui pembiayaan dalaman. Kebanyakan petani (35 peratus) memperoleh antara \$159 dan \$945 setiap tahun sebagai pendapatan daripada penanaman sekoi mutiara. Hasil dari teknik belanjawan ladang menunjukkan bahawa analisa keuntungan bermusim per hektar berkaitan pengeluaran sekoi mutiara di kawasan kajian menunjukkan jumlah pendapatan \$463.24; jumlah kos pengeluaran sebanyak \$262.35; Margin kasar dan pendapatan ladang bersih masing-masing \$233.89 dan \$200.89 telah dihasilkan. Selain itu, PI, RRI dan CTO masing-masing pada 0.43, 0.77 dan 1.77 dihasilkan. Kos input ladang yang menjejaskan keuntungan pengeluaran sekoi mutiara didapati termasuk kos sewa tanah, kos baja, kos buruh, kos biji benih, kos agrokimia dan harga output di mana kos input ladang dikaitkan dengan keuntungan. Keputusan yang diperoleh dari analisis perbatasan stokastik menunjukkan ketidakcekapan teknikal, peruntukan dan ekonomi yang ketara di kalangan petani kecil sekoi mutiara. Hasil kajian mendedahkan bahawa semua enam pemboleh ubah pengeluaran yang digunakan dalam model; saiz ladang, baja, baja, buruh, benih, dan agrokimia mempunyai hubungan teknikal yang positif dengan pengeluaran sekoi mutiara dan adalah signifikan secara statistik. Keanjalan pengeluaran dengan nilai 1.83 menunjukkan bahawa petani sekoi mutiara beroperasi pada pulangan bertambahan mengikut skala. Hasil kajian juga mendedahkan kecekapan teknikal purata sebanyak 82 peratus. Para petani sekoi mutiara yang paling berkemahiran dan paling kurang efisien secara teknikal mempunyai kecekapan teknikal masing-masing pada 96 dan 64 peratus manakala anggaran kecekapan peruntukan adalah antara 30 hingga 91 peratus dengan purata 68 peratus. Purata kecekapan ekonomi adalah 59 peratus, dengan minimum 16 peratus dan maksimum 90 peratus. Hasil kajian dengan ini menunjukkan bahawa ketidakcekapan pengeluaran sekoi mutiara di barat laut Nigeria didominasi oleh ketidakcekapan peruntukan ekonomi. Di samping itu, dalam model OLS, faktor sosioekonomi petani seperti saiz ladang petani, jenis benih, saiz isi rumah, pendidikan, akses kepada kredit dan hubungan lanjutan didapati menentukan kecekapan teknikal. Sebaliknya, umur petani, saiz ladang, pengalaman pertanian, keahlian koperasi, hubungan lanjutan dan jarak ke pasar mempunyai kesan positif terhadap kecekapan peruntukan petani sekoi mutiara. Dalam kes yang sama, saiz ladang, pendidikan, pengalaman, jenis benih, keahlian koperasi, kredit dan hubungan lanjutan merupakan penentu utama kecekapan ekonomi. Keputusan kajian mendedahkan keperluan bagi dasar yang kukuh untuk memastikan cara yang cekap untuk mengakses tanah ladang, baja, buruh dan akses kepelbagaian sekoi mutiara yang lebih baik. Juga, pewujudan badan koperasi atau penyertaan dengan badan yang sedia ada harus digalakkan. Dasar juga harus dibentuk untuk memastikan akses kredit yang mudah dan tepat pada masanya kepada petani sekoi mutiara serta mengukuhkan program lanjutan untuk penyampaian perkhidmatan sambungan yang berkesan dalam bidang kajian.

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This thesis was submitted to the Senate of the Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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# TABLE OF CONTENTS

ABSTRACT	i
ABSTRAK	iii
ACKNOWLEDGEMENTS	v
APPROVAL	vi
DECLARATION	viii
LIST OF TABLES	xiv
LIST OF FIGURES	xvi
LIST OF ABBREVIATIONS	xvii

# CHAPTER |

1

INTE	RODUCTION	1
1.1	Background of the Study	1
1.2	Northwestern Nigeria	3
1.3	Overview of pearl millet production in North-western Nigeria	3
1.4	Policies and interventions related to pearl millet in Nigeria	6
1.5	Problem statement	10
1.6	Objectives of the Study	12
	1.6.1 Main Objective	12
	1.6.2 The Specific Objectives are to:	12
1.7	Significance of the Study	12
1.8	Scope and Limitation of the Study	13

#### 2 LITERATURE REVIEW

LITE	RATURE REVIEW	14	
2.1	Introduction	14	
2.2	Concept of efficiency and its relevance in agricultural		
	production	14	
2.3	Efficiency Measurement	16	
	2.3.1 Parametric (SFA) approach of Efficiency		
	Measurement	17	
	2.3.2 Non-parametric (DEA) approach Efficiency		
	Measurement	17	
2.4	Approaches of Measuring Efficiency	18	
	2.4.1 Input- oriented Efficiency	18	
	2.4.2 Output- oriented Efficiency	20	
	2.4.3 Efficiency studies in other countries	22	
	2.4.4 Efficiency Studies in Nigeria	27	
2.5	Importance of Pearl Millet	30	
2.6	Cost and Returns of Pearl Millet Production		
2.7	Conclusion of the Literature Review	34	

3	MET	HODOLOGY	36
	3.1	Introduction	36
	3.2	Conceptual Framework	36
	3.3	Theoretical Framework	39
	3.4	Sampling Frame	40
	3.5	The Location of Study	40
	3.6	Determination of Minimum Sample Size	42
	3.7	Sampling Method and Sample Size	43
	3.8	Data Collection Procedure	44
	39	Analytical Techniques	45
	5.7	3.9.1 Descriptive Statistics	45
		3.9.2 Budgetary technique	45
		3.9.2 Effects of Inputs Costs on Profitability of	тЈ
		Doorl Millet Production	17
	2 10	Stachastia Frontiar Production Function	4/
	5.10	2 10 1 The Function in Log Form	40
		2.10.2 Specification of the Empirical Model	49
		3.10.2 Specification of the Empirical Model	52
		3.10.3 The Stochastic Frontier Cost Function	52
		3.10.4 OLS regression explaining the determinants of TE,	
		AE and EE efficiencies	54
	3.11	Production Variables and Factors hypothesized to Explain AE,	
		EE and TE Inefficiencies in Pearl Millet Production in North-	
		western Nigeria.	56
		3.11.1 Farm size	56
		3.11.2 Fertiliser	57
		3.11.3 Manure	57
		3.11.4 Labor	57
		3.11.5 Seed	57
		3.11.6 Agrochemicals	58
		3.11.7 Age	58
		3.11.8 Education	58
		3.11.9 Farming Experience	59
		3.11.10 Type of Seed Planted	59
		3.11.11 Membership of Farmer's Organisation	59
		3.11.12 Access to credit	59
		3.11.13 Access to extension services	60
		3.11.14 Household size	60
		3.11.15 Distance to market	60
	3.12	Elasticity of production and returns to scale and their	
	0.112	consequences on marginal physical product (MPP) and profit	
		level	60
			00
4	RESU	JLTS AND DISCUSSION	65
	4.1	Introduction	65

4.1	muouu		05
4.2	Socio-e	conomic characteristics of pearl millet of farmers	65
	4.2.1	Age structure of pearl millet farmers	65
	4.2.2	Gender distribution of pearl millet farmers	66

		4.2.3 Marital status of pearl millet farmers	67
		4.2.4 Number of extension contact	68
		4.2.5 Farming experience of pearl millet farmers	69
		4.2.6 Household size of pearl millet farmers	70
		4.2.7 Educational level of pearl millet farmers	71
		4.2.8 Farm size of pearl millet farmers	72
		4.2.9 Land tenure system of pearl millet farmers	73
		4.2.10 Amount of credit accessed by pearl millet farmers	74
		4.2.11 Sources of credits to pearl millet farmers	74
		4.2.12 Annual income from pearl millet production	75
		4.2.13 Years of membership of co-operatives	76
	4.3	Profitability Analysis of Pearl Millet Production	77
		4.3.1 Results of correlation matrix of variables used in	
		profit function	79
		4.3.2 Results of effects of farm inputs costs on profitability of	. ,
		pearl millet production	80
	44	Results of pre-estimation Diagnostics for variables used in	00
		OLS regression and stochastic frontier production functions	82
		4.4.1 Results of post-estimation diagnostics for variables	02
		used in OI S and SPF models	84
		A A 1 1 Specification error	8/
		4 4 1 2 Normality test	84
		A A 1 3 Heteroscedasticity test	84
		A A 1 A Multicollinearity	85
	4.5	Technical efficiency of smallholder pearl millet farmers	86
	т.5	4.5.1 OLS parameter estimates of average production and	00
		Maximum Likelihood (ML) parameter estimates of	
		SPE for smallholder pearl millet farmers	87
		4.5.2 Electicity of production (Ep) and Return to scale	07
		(PTS)	00
		(K15) 153 Comparison between the officient, everage and least	90
		4.5.5 Comparison between the efficient, average and least	00
		4.5.4 Begulta of correlation matrix showing relationship	90
		4.5.4 Results of correlation matrix showing relationship	
		datorminanta model	02
		4.5.5 Determinents of technical officiancy	93
	16	4.5.5 Determinants of technical efficiency Allocative Efficiency of Smallholder Dearl Millet Fermore	93
	4.0	Anocative Efficiency of Sinalmonder Fear Minet Farmers	90
	17	4.0.1 Determinants of anocative enciency Economic Efficiency of Dearl Millet Droduction	90
	4./	4.7.1 Determinents of according of ficing	99 100
		4.7.1 Determinants of economic enciency	100
	STIN	MARY AND CONCLUSION	102
5	5 1	Summary	102
	5.1	Deliev Implications	102
	5.∠ 5.2	Poter mandations	103
	5.5 5.4	Suggestion for Future Study	100
	א.4 בב	Conclusions	10/
	3.5	CONCIUSIONS	108

REFERENCES	109
APPENDICES	141
BIODATA OF STUDENT	147
LIST OF PUBLICATIONS	148



### LIST OF TABLES

Table		Page
3.1	Distributions of Pearl Millet farmers in the Study Area	43
3.2	Description of inputs cost influencing profitability	48
3.3	Summary Statistics & Expected Signs of the Variables per hectare used in AE, EE and TE Efficiencies	56
4.1	Age Distribution of pearl millet farmers	65
4.2	Distribution of pearl millet farmers based on No. of extension contact	69
4.3	Distribution of pearl millet based on farming experience	69
4.4	Distribution of pearl millet farmers according to household size	71
4.5	Level of education of pearl millet farmers	72
4.6	Distribution of pearl millet production according to their farm size	73
4.7	Distribution of Pearl Millet Farmers based on land tenure system	73
4.8	Distribution of pearl millet farmers based on their access to credit	74
4.9	Distribution of pearl millet farmers based on their sources of credit	75
4.10	Annual income from pearl millet production	76
4.11	Distribution of Pearl Millet Farmers Based on Co-operative	76
4.12	Production costs of pearl millet/ha/cropping season for pooled data	77
4.13	Estimated returns/cropping season/ha from Pearl Millet Production for Pooled data	79
4.14	Correlation matrix of variables used in profit function	80
4.15	Multiple regression estimates showing the effect of farm's input	80
4.16	Correlation coefficients showing linearity relationship between Inputs and outputs	83
4.17	Results of Diagnostic tests for variables used in OLS & SPF models	85
4.18	Variance inflation factor	86

4.19	Technical Efficiency Distribution of Pearl Millet Farmers in Northwestern	87
4.20	OLS and ML parameter estimates based on a sample of pear	88
4.21	Elasticity of production and return to scale for pearl millet Farmers	90
4.22	Comparisons between the efficient, average and least efficient farmers in terms of inputs used per hectare	92
4.2	Correlation matrix showing relationship among variables used in the technical	93
4.24	Determinants of technical efficiency	95
4.25	Allocative Efficiency Distribution of Pearl Millet Production	96
4.26	Determinants of Allocative efficiency	98
4.27	Economic Efficiency Distribution of Pearl Millet Farmers	99
4.28	Determinants of economic efficiency	101

 $\bigcirc$ 

### LIST OF FIGURES

Figure		Page
1.1	Area, Consumption, production and Yield trends of millet in Nigeria from 1996-2016	4
1.2	Production trends of millet in Kano & Jigawa from 1981-2016 (FMAWR, 2017)	5
1.3	Yield trend of millet in Kano & Jigawa from 1970-2018 (FMAWR, 2017)	6
2.1	Input-Oriented Measures for Technical, Allocative and Economic Efficiencies	19
2.2	Output-oriented Allocative and Technical Efficiency	21
3.1	Conceptual Framework for Pearl millet production Efficiency	38
3.2	Maps showing the two selected states: Kano and Jigawa States with their Local	42
3.3	Three stages of production-economic decisions	62
4.1	Distribution of Gender of pearl millet farmers	67
4.2	Marital status of sampled pearl millet farmers	68
4.3	Scatter Plot Showing Linear Relationship between Output and Inputs	83

### LIST OF ABBREVIATIONS

- AE Allocative Efficiency
- CTO Capital Turnover
- CE Cost Efficiency
- CRS Constant Return to Scale
- DEA Data Envelopment Analysis
- DGP Data Generating Process
- DMU Decision Making Unit
- DRS Decreasing Return to Scale
- EE Economic Efficiency
- FAO Food and Agriculture Organisation
- FAOSTAT Food and Agriculture Organization Corporate Statistical Database
- FMARD Federal Ministry of Agriculture and Rural Development
- GDP Gross Domestic Product
- GI Gross Income
- GM Gross Margin
- HOPE Harnessing Opportunities for Productivity Enhancement
- ICARDA International Centre for Agricultural Research in the Dry Areas
- ICRISAT International Crops Research Institute for Semi-Arid and Tropics
- IFAD International Fund for Agricultural Development
- INTSORMIL International Sorghum and Millets
- IRT Increasing Return to Scale
- JSIHB Jigawa State Investment's Handbook
- LCRI Lake Chad Research Institute

- L.G.A. Local Government Area
- MLE Maximum Likelihood Estimates
- NBS National Bureau of Statistics
- NFI Net Farm Income
- NGOs Non-Governmental Organizations
- NPC National Population Commission
- OLS Ordinary Least Square
- PI Profitability Index
- RRI Rate of Returns on Investment
- RTS Return to Scale
- SE Scale Efficiency
- SFA Stochastic Frontier Analysis
- SAT Semi-Arid Tropical
- TE Technical Efficiency
- TFP Total Factor Productivity
- TC Total cost
- TECRS Technical Efficiency Variable Return to Scale
- TEVRS Technical Efficiency Variable Return to Scale
- TR Total revenue
- USDA United States Department of Agriculture
- VRS Variable Return to Scale

### **CHAPTER 1**

#### **INTRODUCTION**

### **1.1** Background of the Study

Regional staples around the worlds are traditionally identified by their ability to thrive in ideal conditions provided by their native environments. Pearl millet is an important cereal that makes up about two-third of the total cereal production in Africa and it is regarded as one of the world's four most essential cereal crops (millet, rice, maize and sorghum). Its ability to withstand stress and thrive in hot regions have made it quite popular in hot regions and especially across many African countries which account for about 55 percent of the global total pearl millet production and also take up 59 percent of the global total area under pearl millet cultivation (Bhagavatula et al., 2013). Within Africa, more than 13.63 million hectares is put to use, accounting for about 74 percent of the total area cultivated in Africa and 28 percent of the world total production is in West Africa. Nigeria, as one of the most important millet producing countries in the world, produces almost half (40 percent) of total African millet production according to FAO (2013). Globally, production is on an estimated 26 million hectares spread over 40 countries that are mostly arid and semi-arid (where rainfall is not sufficient (200-600 mm) tropical (SAT) areas of Africa and a few other countries in Asia.

The northern part of Nigeria provides an ideal agro-ecological condition for the production of pearl millet. For this reason, it is predominantly produced and consumed within the region, making it a staple for over 40 percent of the populace (Jirgi et al. 2010). Interestingly, it is a valuable component of the people's livelihoods because no part of the plant is wasted. As a regional staple, the people have created diverse methods and forms of processing it for consumption such as thick paste (locally called 'tuwo'), thick dough (locally called 'fura'), dumplings, grits, porridge and gruel. Beyond food, it is used as animal feed while the stalks of some varieties are traditionally used as building materials and for firewood. A breakdown of its uses suggests that 78 percent of pearl millet produced in Nigeria is consumed as staple food, 20 percent is used for drinks and other products and 2 percent is used as feed (Usman et al. 2014). The importance of millet extends beyond food: its production also serves as an important source of income for farmers. Nigeria's food supply is primarily provided by smallholder farmers, accounting for about 80 percent of the country's total farmers' population (Akinsuyi, 2011). These smallholder farmers are confined to the rural areas where they depend on farming as their main source of income. Exact official estimate of total number of millet farmers is unavailable, however, with millet production estimated to cover about 14.2 percent of total cereal land coverage in Nigeria (FoodFarm News, 2018), an appreciation of the crop as an important source of livelihood is justified.



The Nigerian consumption level of the rural populace who form 53 percent of the Nigerian population (Cheng and Larochelle 2016) is significant, and over the last two decades, an average per capita consumption of 32kg per year was reported by Food and Agricultural Organization (FAO, 2015). Trends reveal a rather stable pearl millet consumption in Nigeria, where per capita consumption was observed to hover around an average of 30kg per year between 1991 and 2010 (Cheng and Larochelle, 2016). Over time, the contribution of pearl millet to the diets of households in Nigeria stands at an average of 260 kcal per capita per day. The crop is, therefore, essential for the nation's food security, as supported by Cheng and Larochelle (2016) who emphasized that households' demands for pearl millet crop will increase as income grows in northern Nigeria, but at a lower rate than the income growth. This is because demand for pearl millet among rural households who make up about 53 percent of the Nigeria's population (Cheng and Larochelle 2016) is less responsive to price and income changes compared to with urban household. Thus, taking into account the high population growth rate and increasing urbanization rate in the country, it is expected that total demand for pearl millet as food will continue to increase.

In recognition of the crucial role millet plays in the regions' food security, the Nigerian government in 1975, established 'Lake Chad Research Institute (LCRI)', mandated to facilitate research in millet production in the country by way of developing improved technologies. Over the years, the agency has made appreciable achievements through the release of improved varieties such as LCIC MV-1 (SOSAT – C88) and LCICMV-3 (Super SOSAT) with potential yields of 3.0 – 4.0 tones ha<sup>-1</sup> (LCRI, 2018). Other concerted efforts such as with International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) to promote millet production have been in existence since 2008.

Unfortunately, despite the aforementioned government's efforts, the last decade has seen a decline in millet production in Nigeria. FAO (2018) listed the main factors undermining crop production in Nigeria to include reliance on rain fed agriculture, smallholder land holdings, and low productivity due to poor planting material, low fertilizer application, and a weak agricultural extension system amongst others. The government on its part has not provided significant encouragement on its part. Recently, the government's attitude of directing policies in the form of subsidies towards promoting rice production will only further weaken the millet industry. To compound the situation, religious sectarian crisis in the north-eastern part of the country, where millet is highly produced has contributed to its progressively shrinking acreage, thereby overburdening the north-central and north-western parts of the country as the main suppliers. It is necessary to understand that millet production deserves some government's attention because an important feature of the millet crop is its tolerance for much less water compared to rice and wheat and can be successfully cultivated in semi-arid tropics and on poor soils. With an increasing competition for water in irrigation agriculture and erratic rainfall regimes peculiar to the northern part of the country, promoting millet production to meet rising demand for nutritious food should be a necessary policy focus. Vast



arable land in the region suitable for millet production present a foreseeable hope for the future of millet production. However, without government's support, the outlook for millet production appears to be bleak.

### 1.2 Northwestern Nigeria

The north-western region boasts of a relatively large land mass and a substantial agricultural sector, ranging from small and large scale crop production and livestock rearing. There are seven (7) states in Nigeria that make up the North-western region. These include; Jigawa, Kaduna, Kano, Katsina, Kebbi, Sokoto and Zamfara states, with Kano state being the most populous (40 percent of the total population in the region) (NPC, 2010). Although, crop production has been a part of the region's culture, tradition and overall livelihoods since time immemorial, yet most of the poorest states in Nigeria fall in this region, which is attributed to agricultural low productivity. The poverty line in this region was 35 percent as indicated by national headcount poverty ratio in 2010/2011 (Cheng and Larochelle, 2016).

The region consists of a close network of rivers and streams, some of which are seasonal. An imp surface water basin in the region is the Niger Basin, with an area of 584,193 km<sup>2</sup> within the country, which is 63 percent of the total area of the country, and covers a large area in central and north western Nigeria (FAO-Aquasat, 2018). This wide range of agro-ecological conditions allows for a diversity of crop production activities. While the dry savannah parts are suitable for rain-fed cereals production system particularly sorghum, millet, maize, sesame, groundnuts and cowpea, the region's water systems on the other hand encourage the production of vegetables, rice and wheat, under irrigation conditions. According Anderson et al. (2017), farming system in northern Nigeria is predominantly smallholder-based with a high incidence of land fragmentation (typical farm sizes in the region less than 5 hectares (0.5 ha to 4 ha), characterised by simple, low-input technology which creates a challenge of low productivity.

### **1.3** Overview of pearl millet production in North-western Nigeria

This section firstly reviews the overall performance of the country's millet industry, so as to provide some idea of a broader national scene in which the region being studied measures up.

Within the last two decades, Nigeria has consistently been ranked among the top world's millet producing countries. The country's impressive performance in millet production is due to a combination of factors such as favorable growing conditions and the government's research efforts in seed development. Figure 1.1 presents trends of key indicators of millet in Nigeria. Production maintained a steady

increase from 2001, peaking in 2008 mainly due to yields increases because area harvested recorded a drop of 3 percent in the same year. The year 2011 ushered in the poor performance period in the industry for the last two decades under investigation. Probable reason is that the year 2012 coincided with the peak of an infamous religious sectorial crisis in the north-eastern region- a significant producer of millet in the country. The crisis had an overall devastating effects on agricultural activities including crop production, livestock and fishing activities, and therefore, most likely the reason for the poorest production year of 2013, which recorded 910,000 tonnes. The crisis might have affected yields as well since affected farmers may lack financial capacity to buy high yielding varieties. Official figures on exports and imports are unavailable and so data provided indicate that the volumes produced are totally consumed (Figure 1.1) in the country. Contrary to that, it is possible that millets are exported to neighboring countries like Niger Republic and Chad through Nigeria's porous borders. These observations of the overall performance indicate the need for government's interventions like input subsidies.





Bulk of pearl millet production is from north-western region which contributes a greater proportion of the national production. States like Jigawa and Kano states' production trend was on average of 1.5 million tons in 1970s through 1980s. In the 1990s through 2000s, the trend showed an upward shift to 2.1 million tons which positioned these states as the largest pearl millet producing states in the country (FMAWR, 2017). These performances contributed to the overall performance of the country, which was ranked the second largest world millet producer after India. Production trends in these two states increased further to 2.7 million tons during

2001 to 2010 which made the states and the country maintain their positions of the first and second largest producers in the national and world ranking, respectively. However, the performance of this vital cereal crop suddenly started declining. This is because during 2011 to 2016, the average annual production in these two states decreased to just 0.78 million tons. The manifestation of this decreased in production was witnessed in shrinking of total country production forcing it to lose its second position in the world to Niger, China and Mali by dropping to 5<sup>th</sup> position (2016). The production trend of pearl millet in in the study area from 1981 to 2016 is depicted in Figure 1.2 below.



Figure 1.2 : Production trends of millet in Kano & Jigawa from 1981-2016 (FMAWR, 2017)

In addition, the pearl millet yield trends in these states follow a similar pattern as production, where it was static at 0.60-0.80 tons ha-<sup>1</sup> between 1970 and 1980. It then increased slightly to 1.26 tons ha-<sup>1</sup> within the period 1981-1990, the time when Nigeria occupied third position in the world ranking. But during 2001-2010, the yield trend showed slight decline to 0.97 tons ha-<sup>1</sup>. Being two of the states with very high concentration of pearl millet producer, the effect this yield decrease was experienced in drop of the country's position in world ranking to 30<sup>th</sup> in the same period. Although the yield step-up to 1.42 tons ha-<sup>1</sup> in 2001-2010 in these two states and maintained their number one position in the country, the Nigeria position in the world continued to stagnant at 30<sup>th</sup> indicating that the yield was far less than what was obtainable in other countries. Finally, in 2011-2016 the average yield showed a tremendous shrinkage to 1.07 tons ha-1 with the national average yield descending further down to 65<sup>th</sup> in the global ranking (JSMA 2013; FMAWR 2017; FAOSTAT 2017). The yield trend of millet in study area from 1981 to 2016 is illustrated in Figure 1.3 below.





Figure 1.3 : Yield trend of millet in Kano & Jigawa from 1970-2018 (FMAWR, 2017)

### 1.4 Policies and interventions related to pearl millet in Nigeria

Efforts to improve the production and productivity of this crop have been employed by different government administrations, as part of interventions to promote millet productivity and value addition. The government has at various times developed and implemented series of Agricultural Development Programs and policies were implemented by successive governments to address the various problems that are limiting the overall development of the sector. The main focus involves the empowerment and capacity development of the smallholder families.

The crop has received increased attention within the Nigeria's production structures. For example, Lake Chad Research Institute (LCRI) was established in 1975 and saddled with genetic improvement of millet as one of its mandates. Other few of the policies and programs related to major food cereals (pearl millet inclusive) were the National Special Program for Food Security (2002), the National Agricultural Production/Productivity Outlook (2012), the New National Agricultural Policy (2001), the National Economic Empowerment and Development Strategy (2011), the Presidential Initiatives on Commodities (2005), the 7-Point Agenda (2008) and the Agricultural Transformation Agenda (2013) among others.

Particularly, in recognition of the role pearl millet can play in food security especially in arid and semi-arid zones, different policies and programs have been introduced with regard to enhancing pearl millet productivity in Nigeria. For example, the federal government of Nigeria and International Fund for Agricultural



Development (IFAD, 2003; 2016) initiated several programs among which are the "Farmer Participatory Testing of Technologies to Increase Sorghum and Pearl Millet Production in the Sahel" and "Traditional Food Crops Project" to improve smallholders' incomes and food security through increased production of traditional food crops including pearl millet. The main aim of these projects was to encourage farmers to adopt these improved varieties in order to increase food production and rural incomes.

Pearl millet improvement programme in Nigeria is concerned with higher yield for human food and this would possibly play a major role in easing the world food scarcity as population skyrockets. The Federal Ministry of Agriculture and Rural Development (FMARD, 2014) reports that the purpose of increasing pearl millet production in Nigeria was actually aimed to meet the ever growing demand for food. This increase in productivity depends on the success of research in pearl millet cultivation and hybrid improvement programmes.

With regards to seeds, many researches on pearl millet breeding have been in progress and there is substantial documentation about this within Sub-Saharan Africa. International Crops Research Institute for Semi-Arid and Tropics (ICRISAT) recently developed stable, high-yielding millet varieties (LCRIMVs), because of its low input requirements and ability to grow well in arid and semi-arid zones compared with most staple cereals like rice and maize (Ndjeunga et al., 2011). For example, SOSAT C88 pearl millet variety under the varietal name (LCICMV-1) was released in the year 2000 by the Nigerian National Variety Release Committee (NNVRC) for production throughout the country (Ndjeunga et al., (2011). In almost the same period, other prominent stable high-yielding varieties (GB8735, LCIC 9702, LCIC 9703, and ZATIB) which are suitable to the Northern region were developed and released jointly by ICRISAT, Institut d'Economie Rurale (IER) and LCRI. A remarkable breeding success also was achieved by INTSORMIL through introduction and release of early maturing pearl millet hybrid variety named LCICMH-I. SUPERSOSAT (PE05578), which was also released in Nigeria in December, 2011. All these improved varieties were developed with the sole aim of increasing farmers' productivity and have the potential yield of 2.5 to 4.0 tons/ha, with 39percent yield advantage over the local variety (Obilana, 2013).

To further promote millet production, several public efforts supplemented by Non-Governmental Organizations (NGOs) and other stakeholders provided interventions targeted at improving productivity and marketing of pearl millet. Bill and Melinda Gates Harnessing Opportunities for Productivity Enhancement (HOPE), International Centre for Agricultural Research in the Dry Areas (ICARDA), International Crops Research Institute for Semi-Arid and Tropics (ICRISAT), and International Sorghum and Millets (INTSORMIL) funded projects which developed interventions like breeding, distribution of improved millet varieties and the promotion of resource conservation and management to address productivity and marketing challenges. The Sassakawa Global 2000 (SG2000)

signed agreement with Federal Ministry of Agriculture and Natural Resources (FMARNR) to work with federal and state agencies to raise agricultural productivity and improve major food crops marketing including pearl millet.

However, despite all these numerous efforts aimed at improving pearl millet production in Nigeria, performance of pearl millet among smallholder farmers has either stagnated or progressed at a very slow pace, placing the average yield for this vital crop at 1.0-1.1 tons ha-<sup>1</sup> as against the potential yields of 2.5-4.0 tons ha-<sup>1</sup> (Soule *et al.*, 2010; JSMA, 2013; FAOSTAT, 2017). This implies that a substantial yield gap still exists between the farmers' output levels and the expected yields based on the potentials of the improved varieties developed.

These negative effects of low productivity have resulted to increase in imports of substitute cereals like maize, rice and wheat to complement the deficit in food demand of the population which is both economic and food insecurity. According to Jane (2016), Nigeria is the second largest rice importer in the world. Nigeria government expended an outrageous \$2.41 billion on importation of rice between 2012 and 2015 (Abbas et al. 2018). According to FAO (2016) in 2016 alone, Nigerian import value on rice amounted to \$500 million. Also, the country spent about an average of \$1.2 million each year from 2014 to 2017 (USDA 2018). With regards to maize the importation estimated at  $\aleph$ 82.13 billion (\$228.14 million in 2017 (New telegraph, 2017).

This means that huge investments made in the improve pearl millet have not produced considerable result as expected, suggesting that all the efforts have not contributed much increased technical efficiency (TE) and improved productivity. This is due to the fact that bridging the gap between the potential yields of the improved pearl millet varieties developed and the existing average yield obtained by farmers is one of the ways to increase pearl millet output.

Since increased productivity has direct correlation with efficiency, this low productivity reflected the possibility of inefficiency among pearl millet farmers in the study area. In Nigeria, inefficiency in pearl millet production may also be associated to agronomic, physiological, political, socioeconomic factors and poor resource management practices. Socioeconomic factors (age, experience, family size, education, credit, extension, proximity to markets, farm size, off-farm activities etc.) and poor management (inputs use) are more obvious of all the factors (Shanmugam, 2006; Forsund *et al.* 1980; Rahman and Umar, 2009; Ahmed *et al.*, 2016). Favorable conditions of farm and socioeconomic factors are known to increase production. When socioeconomic and farm factors are unfavorable, farmers allocate un-proportionate resources/inputs for production than necessary. Inefficiency may also results from wrong combination of farm inputs, inadequate supply of quality seed, cultivation of small farm size, poor agricultural practices, poor quality planting materials, use of crude farm tools, inadequate fertilizer

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application, inadequate of financial resources and lack of extension, among others (Rahman *et al.*, 2008; Paul, 2011).

Efficiency influences agricultural production directly by increasing available food sources and indirectly by raising income of the farming household. Although, it is not the only key for reducing food insecurity and poverty, but no nation has ever successfully achieved them without first increasing its level of agricultural productivity and efficiency in addition to other industrial and institutional development (POSTnote, 2006). This highlights the importance of the study of efficiency to all economies, especially the developing ones like Nigeria

Conversely, in the face of declining trend in pearl millet production and productivity in Nigeria, there is an apparent need to study pearl millet production profitability. Low level of production leads to high prices of output which has been a hindering factor towards the full capitalization of the pearl millet sub-sector commercialization process (Ahmed, 2004). This is for the fact that farming practices with low profits could generate and perpetuate poverty among smallholder pearl millet farmers. Adequate return on investment through profit generation is a good enticing reason for producing high quality products while ensuring economic efficiency (Rembisz, 2011). Consequently, increasing farm efficiency of small-scale farmers increases their output which improves food security by raising smallholder farmers' income (Mango *et al.*, 2015). While inefficiency in farm production raises the costs of production and make a farm or firm less competitive (Alverez and Arias, 2004). For the reason that those farmers that are efficient have a tendency to have higher farm incomes and this provides better opportunity for the prosperity and survival in their farm business.

The important role of pearl millet production in the north western region in both the attainment of food security and overall socio-economic development highlights the need for a more efficient and more economically viable production that is profitable to the smallholder producers. In this respect, it is imperative to study efficiency and profitability as well some of the socioeconomic/farm-specific factors that influence the efficiency. This will help in providing vital information for appropriate policy formulations for increased productive efficiency and profitability.

A considerable amount of these production are spared as surpluses and are exported to neighboring countries like Niger, Chad, Cameroun, Ghana and Burkina Faso where demand is also high. Although there are no official statistical data on exports, it is nonetheless described as significant (Soulé *et al.* 2011).

#### 1.5 **Problem statement**

The prospect of pearl millet production in Nigeria is emphasized in its immense contributions to food security, poverty alleviation and income growth. Unfortunately, recent production estimates have shown disappointing trends, indicating a potential threat to food security in the north-western region of the country. To mitigate this, various organizations including Nigeria's federal and state governments, NGOs and other stakeholders have invested a lot of resources towards research and development of inputs towards pearl millet production. However, results have shown overall failures of such efforts.

A modern approach to agricultural production involves the adoption of high value agricultural inputs in many developing nations which have shown impressive outcomes. This approach to seem to not be a favoured option in pearl millet production in north-western Nigeria and this attitude could be the reason for the recent failing productions. Pearl millet production can be improved either by increasing its area or by increasing its yield per unit area. However, the former option could be a difficult feat due to factors like competition for land. Hence, increasing production through yields improvement presents better prospects. To do this, an important step is to study farming techniques employed by pearl millet farmers in the area so as to determine their efficiencies. This is because, although the use of modern farm inputs and technologies are necessary for production improvements, a more important aspect - efficiency in the use of such inputs, is necessary otherwise, the recent unfavourable trends in production will linger and probably lead to devastating consequences on food security.

A food consumption survey revealed that pearl millet products is the most often consumed staple in northern Nigeria, with over 40 percent of the population relied on it for their daily food in different forms. The declining trends on quantities of pearl millet produced has been evident at both states and national level, with a majority of the country's pearl millet farmers recording substantial gaps in average yield (0.9 ton ha<sup>-1</sup> as against the potential yield of 2.5 - 4.0 tons ha<sup>-1</sup> (JSMA 2013; FMAWR, 2017). Since available literatures show a direct correlation between productivity and efficiency, it is safe to say that this low performance of pearl millet in north-western Nigeria (and the country as a whole) reflects an existence of inefficiency among the pearl millet farmers. This presents a need to bridge the gap between the potential yields and the existing average yield obtained by farmers. The negative effects of low millet productivity have pervasive consequences such as lowering incomes for farmers and increase in consumption and imports of substitute cereals like maize, rice and wheat to supplement the deficit in food demand of the country.

Various factors have been documented to be responsible for inefficiency effects in food crops production. In Nigeria, inefficiency in pearl millet production may be associated with agronomic, physiological, political, socioeconomic factors and poor resource management practices. However, socioeconomic factors such as farming experience, access to credit, extension and proximity to markets and poor management in terms of inputs use stand out (Shanmugam, 2006; Forsund *et al.* 1980; Rahman and Umar, 2009; Ahmed *et al.*, 2016).

Considering the prevailing new technology, improvements in the efficiency will greatly enable smallholder farmers to produce the maximum possible output from a given level of inputs. Therefore, pearl millet productivity will be increased by improvements in farmers' efficiency levels. Although limited studies have been carried on economic and agronomic aspects of pearl millet production in Nigeria, hitherto there exist inadequate empirical research on farm efficiency levels and knowledge of smallholder farmers' production technologies remain scarce, particularly in the north-western region. This is further buttressed by Rahman 2013 who noted that attainment of an optimally high level of output with a given quantity of inputs or amount of effort is the major goal of any production system.

Conversely, in the face of declining trend in pearl millet production and productivity in Nigeria, there is an apparent need to study pearl millet production profitability. This is because examining profitability measures will shed more insight into the failing millet production system in Nigeria. For example, farming practices with low profits not only mean a creation and perpetuation of poverty incidences among pearl millet farmers, but also, a deterioration of the industry due to crowding out of farmers from the industry. Adequate return on investment through profit generation is a motivation for producing high quality products while ensuring economic efficiency. Consequently, increasing farm efficiency of small-scale farmers' income (Mango *et al.*, 2015). Rembisz (2011) supported that improving farm level efficiency can bring about increased profitability. This is explained by the fact that efficient farmers have a tendency to have higher farm incomes which fosters the prosperity and survival of their farm business.

Therefore, this comprehensive study focuses on efficiency and profitability analysis of pearl millet production and further to identifies the factors responsible for its levels of technical, allocative and economic efficiencies in north-western region of Nigeria. In the process, the following research questions emerged:

i. Is small-scale pearl millet production profitable in the study area?

- ii. What are the technical, allocative and economic efficiencies of smallholder pearl millet farmers in the study area?
- iii. Is there any difference in level of inputs used by the efficient, average efficient and least efficient pearl millet farmer in the study are?
- iv. What are the factors contributing to technical, allocative and economic efficiencies of the pearl millet production in the study?

### **1.6 Objectives of the Study**

### 1.6.1 Main Objective

The main objective of this study is to analyze the profitability and efficiency of smallholder pearl millet production in northwest region of Nigeria.

### **1.6.2** The Specific Objectives are to:

- i. estimate the profitability level of smallholder millet farmer
- ii. determine the level of technical, allocative and economic efficiencies of smallholder pearl millet farmers
- iii. compare the level of inputs used by the most efficient, average efficient and inefficient pearl millet farmers in the sample.
- iv. identify the factors contributing to technical, allocative and economic efficiencies of the pearl millet production

### 1.7 Significance of the Study

Pearl millet is known as one of the three priority staple crops in northeastern and northwestern Nigeria where about 30percent of the cultivable land is devoted for its production. It is one of the crops chosen by states and federal governments as well as other non-governmental organizations in effort to increase household incomes and nutritional status of northern Nigeria low-resource farmers through increased production, productivity and marketing. This depends on the good understanding of the region, climate condition and the farmers on crop intensification program.

Pearl millet is also an important cereal crop cultivated in almost all parts of Nigeria. It is commonly considered as low status food of the rural people due to its low comparative to rice, wheat and maize for example. Pearl millet also provides traders and farm households with incomes and it is therefore important from both income generation and food security.

The issue of quantifying efficiency and consequently the cost-effective performance of this crop is of paramount importance to both farmers and policy makers. Efficiency improvement can lead to saving excessive costs of production, through increasing prudent use of inputs. Improving farm management practices and rational inputs allocation to attain the optimal output levels are necessary for farm efficiency. This is of great importance for those farmers whose intention is to optimize their production decisions, particularly under conditions of high inputs cost, rapid technological advancement, changing marketing conditions and economic hardship. For policy makers who are interested in improving economic performance and competitiveness of the agricultural sector as well as promoting economic development and sustainable economic practices, this study would be very significant in these respect.

This study has the major contributions in Nigeria. First, it contributes to a scarce literature on the efficiency of millet, while concurrently providing empirical evidence on the farm level efficiency of millet production. Furthermore, in the study area, where millet is a staple food, there has not been any existing published study that investigated efficiency at farm level using farmers from either of these two states or both or the whole region and the country.

Secondly, the study would directly contribute to the effort of meeting food security in these states, the region or the country at large; this is due to the fact that when production efficiency is improved the productivity and accessibility to food would be improved. It will also provide information on how to minimize inefficiencies in pearl millet production and improve both productivity and standard of living thereby having positive implications on food security and economic growth of the country.

Therefore, this study has an exceptional contribution towards helping policy makers in making policies associated with pearl millet production and profitability.

### **1.8 Scope and Limitation of the Study**

The study was based on the information gathered from memory recalled by the farmers and primary data largely on production during 2013/2014 in the study area. Due to the low educational level of most of the respondents, accurate record of their farming activities is not documented and this made data collection very difficult during the survey period. Financial constraints, insufficient time and non-availability of information with regard to the topic of study (efficiency and profitability of pearl millet production) were the major hurdles to the current study. The study was confined and limited to estimation of efficiency and profitability of pearl millet farmers in Jigawa and Kano states only. These two states were selected based on high concentration of pearl millet growing farmers and their history in pearl millet production. The study would be conducted within two years.

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